REMARKS

Applicants appreciate the thorough examination of the present application, and the indication of patentable subject matter in Claims 62-69. Applicants have amended Claim 62 to independent form incorporating recitations from Claim 58, and have amended Claim 63 to depend from Claim 62, such that Claims 62-69 are now in condition for allowance. Applicants have canceled Claims 42-57 without prejudice or disclaimer towards pursuing these claims in a divisional application. Applicants have amended Claim 58 to further highlight patentable distinctions between the claimed invention and U.S. Patent Application US 2002/0063274 to Kanaya et al. ("Kanaya"), and have added new Claims 73-76, which depend from amended independent Claim 58, and new Claim 77, which depends from Claim 62. Applicants have also amended several of the claims to correct an inadvertent error in expressing the chemical formula for tantalum pentoxide (Ta_2O_5). Applicants submit that these amendments introduce no new matter, as one skilled in the art would have recognized the inadvertent error. Reasons for patentability of the claims are discussed in detail below.

Amended Independent Claim 58 is patentable over Kanaya

Independent Claim 58 stands rejected under 35 U.S.C. §102(e) as anticipated by Kanaya. In particular, the Office Action cites Figs. 20A-20C and paragraph [0128] and [0129] of Kanaya as teaching the recitations of Claim 58.

Applicant has amended Claim 58 to further clarify that the first metal oxide layer is a different material than the ferroelectric dielectric region. In contrast, the layers 113, 114 referred to in paragraph [0128] of Kanaya are both PZT ferroelectric material layers. Accordingly, the cited passage from Kanaya does not disclose or suggest "depositing a first metal oxide layer of a different material than the ferroelectric dielectric region directly on a surface of the ferroelectric dielectric region" and other operations recited in Claim 58. For at least these reasons, Applicants submit that amended Claim 58 is patentable over Kanaya.

The dependent claims are patentable

Applicants submit that dependent Claims 59-77 are patentable at least by virtue of depending from various ones of patentable independent Claims 58 and 62. Applicants further submit that, in addition to Claims 63-69 that were already indicated as having separate bases for patentability, several other of the dependent claims are separately patentable.

For example, Claim 59 recites ". . . wherein the first metal oxide layer is sufficiently thin enough to enable a remnant polarization of the ferroelectric dielectric region to increase during the annealing of the first metal oxide layer and the ferroelectric dielectric region." Paragraph [0128] of Kanaya, cited in rejecting Claim 59, merely indicates that a heat treatment of PZT layers 113, 114 on a platinum (Pt) electrode 112 crystallizes the PZT film 114, and that during this crystallization, Pt "is hardly diffused in the second PZT film 114." This passage provides no indication of any effect of the operations described therein on ***remnant polarization***, or of any relationship between the thickness of a metal oxide layer formed on a ferroelectric layer and remnant polarization. For at least these reasons, Applicants submit that Claim 59 is separately patentable over Kanaya. Similar arguments support the separate patentability of Claim 60.

Claim 61 recites ". . . wherein the first metal oxide layer is sufficiently thick enough to reduce diffusion of hydrogen into the dielectric region during the depositing of the second metal oxide layer." The cited paragraph [0128] says nothing about the diffusion of ***hydrogen*** in a ferroelectric dielectric region. For at least these reasons, Applicants submit that Claim 61 is separately patentable.

CONCLUSION

Applicants have placed Claims 62-69 in condition for allowance, have amended Claim 58 to further highlight patentable distinctions over Kanaya, and have added new Claims 73-77. Applicants respectfully request allowance of Claims 58-75 and passing of the application to issue in due course. If any informal matters remain

to be resolved, the Examiner is encouraged to contact the undersigned by telephone at (919) 854-1400.

Respectfully submitted,

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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: BOX NON-FEE AMENDMENT, Commissioner for Patents, Washington, DC 20231, on March 17, 2003.

Candi L. Riggs
Date of Signature: March 17, 2003

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

Paragraph beginning at line 15 of page 3 has been amended as follows:

In still other embodiments of the present invention, an integrated circuit comprises a ferroelectric dielectric region on a substrate, a first metal oxide layer directly on a surface of the ferroelectric dielectric region, and a second metal oxide layer on the first metal oxide layer. The first metal oxide layer is configured to enable a remnant polarization of the ferroelectric dielectric region to increase during an annealing of the substrate before formation of the second metal oxide layer. The first metal oxide layer preferably is thick enough to substantially impede diffusion of hydrogen into the ferroelectric dielectric region in, for example, subsequent fabrication operations. The first metal oxide layer may comprise a metal oxide selected from the group consisting of Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] $\underline{Ta_2O_5}$ and CeO_2. Similarly, the second metal oxide layer may comprise a metal oxide selected from the group consisting of Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] $\underline{Ta_2O_5}$ and CeO_2. The first and second metal oxide layers may be formed from the same material. In embodiments of the invention, the second metal oxide layer is thicker than the first metal oxide layer. For example, the first and second metal oxide layers may comprise respective first and second metal oxide layers, with the second metal oxide layer being at least about twice as thick as the first metal oxide layer, and less than about ten times thicker than the first metal oxide layer.

Paragraph beginning at line 12 at page 13 has been amended as follows:

The first blocking layer 40 and the first protection layer 42 may be formed of the same material. The first blocking layer 40 and the first protection layer 42 may be formed of metallic oxide, preferably, Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] $\underline{Ta_2O_5}$, or CeO_2. The first blocking layer 40 and the first protection layer 42 may be formed using a method such as an atomic layer deposition method, a low or high pressure chemical

vapor deposition method or a plasma chemical vapor deposition method. The first blocking layer 40 may be deposited by one of the methods mentioned above, and then annealed. It is preferable to use a rapid thermal process for the annealing. The first protection layer 42 may be deposited by one of the methods mentioned above, and may be selectively annealed.

Paragraph beginning at line 7 at page 16 has been amended as follows:

Like the first blocking layer 40 and the first protection layer 42, the second blocking layer 48 and the second protection layer 50 may be formed of the same material. Like the first blocking layer 40 and the first protection layer 42, the second blocking layer 48 and the second protection layer 50 may be formed of metallic oxide, preferably, Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] $\underline{Ta_2O_5}$, or CeO_2. The second blocking layer 48 and the second protection layer 50 may be formed using a method such as an atomic layer deposition method, a low or high pressure chemical vapor deposition method or a plasma chemical vapor deposition method. The second blocking layer 48 may be deposited by one of the methods mentioned above and annealed. It is preferable to use a rapid thermal process for the annealing. The second protection layer 50 may be deposited by one of the methods mentioned above and may be selectively annealed.

Paragraph beginning at line 13 at page 18 has been amended as follows:

The protection spacer 240 and the blocking spacer 242 may be formed of the same material as the first protection layer 42 and first blocking layer 40 of the first encapsulating layer and the second protection layer 50 and second blocking layer 48 of the second encapsulating layer illustrated in FIGS. 2A through 2C. For example, they may be formed from a metallic oxide, preferably Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] $\underline{Ta_2O_5}$, or CeO_2.

Paragraph beginning at line 20 of page 19 has been amended as follows:

The first blocking layer 248 and the first protection layer 250 may be formed of the same metallic oxide as the protection spacer 240 and the blocking spacer 242,

preferably, of Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] Ta_2O_5, or CeO_2. The first blocking layer 248 and the first protection layer 250 may be formed by a method such as a high pressure chemical vapor deposition method, a low pressure chemical vapor deposition method, a plasma chemical vapor deposition method or an atomic layer deposition method.

In the Claims:

Claims 46, 54, 58, 62 and 63 have been amended as follows:

46. (Amended) The method of claim 45, wherein the metallic oxide layer is formed of one selected from the group consisting of Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] Ta_2O_5 and CeO_2.

54. (Amended) The method of claim 53, wherein the metallic oxide layer is formed of one selected from the group consisting of Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] Ta_2O_5 and CeO_2.

58. (Amended) A method of forming a protective structure for a ferroelectric dielectric region on an integrated circuit substrate, the method comprising:

depositing a first metal oxide layer of a different material than the ferroelectric dielectric region directly on a surface of the ferroelectric dielectric region;

annealing the first metal oxide layer and the ferroelectric dielectric region; and

depositing a second metal oxide layer on the first metal oxide layer.

62. (Amended) [A method according to Claim 58:] A method of forming a protective structure for a ferroelectric dielectric region on an integrated circuit substrate, the method comprising:

depositing a first metal oxide layer directly on a surface of the ferroelectric dielectric region;

annealing the first metal oxide layer and the ferroelectric dielectric region; and

depositing a second metal oxide layer on the first metal oxide layer,

wherein the first metal oxide layer comprises a metal oxide selected from the group consisting of Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] $\underline{Ta_2O_5}$ and CeO_2; and

wherein the second metal oxide layer comprises a metal oxide selected from the group consisting of Al_2O_3, TiO_2, ZrO_2, [Ta_5O_3] $\underline{Ta_2O_5}$ and CeO_2.

63. (Amended) A method according to Claim [58] 62, wherein the second metal oxide layer is thicker than the first metal oxide layer.

Claims 73-77 have been added:

73. (New) A method according to Claim 58, wherein the first and second metal oxide layers are non-ferroelectric material layers.

74. (New) A method according to Claim 58:

wherein the first metal oxide layer comprises a metal oxide selected from the group consisting of Al_2O_3, TiO_2, ZrO_2, Ta_2O_5 and CeO_2; and

wherein the second metal oxide layer comprises a metal oxide selected from the group consisting of Al_2O_3, TiO_2, ZrO_2, Ta_2O_5 and CeO_2.

75. (New) A method according to Claim 74, wherein the ferroelectric dielectric region comprises a ferroelectric material selected from the group consisting of $SrTiO_3$, $BaTiO_3$, $(Ba, Sr)TiO_3$, $Pb(Zr, Ti)O_3$, $SrBi_2Ta_2O_9$, $(Pb, La)(Zr, Ti)O_3$ and $Bi_4Ti_3O_{12}$.

76. (New) A method according to Claim 58, wherein the second metal oxide layer is thicker than the first metal oxide layer.

77. (New) A method according to Claim 62, wherein the ferroelectric dielectric region comprises a ferroelectric material selected from the group consisting of $SrTiO_3$, $BaTiO_3$, $(Ba, Sr)TiO_3$, $Pb(Zr, Ti)O_3$, $SrBi_2Ta_2O_9$, $(Pb, La)(Zr, Ti)O_3$ and $Bi_4Ti_3O_{12}$.

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